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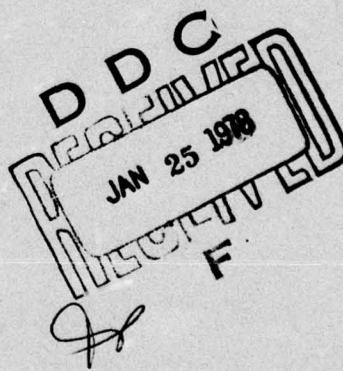


USAF BIOENVIRONMENTAL NOISE DATA HANDBOOK

Volume 115

D-4 Test Stand, Aircraft Hydraulic System

DECEMBER 1976



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**AEROSPACE MEDICAL RESEARCH LABORATORY
AEROSPACE MEDICAL DIVISION
AIR FORCE SYSTEMS COMMAND
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The D-4 Hydraulic Test Stand is an electric motor-driven unit designed to test aircraft hydraulic systems. This report provides measured data defining the bioacoustic environments produced by this unit operating inside a large aircraft hanger at normal rated/loaded conditions. Near-field data are reported for 37 locations in a wide variety of physical and psychoacoustic measures: overall and band sound pressure levels, C-weighted and A-weighted sound levels, preferred speech interference level, perceived noise level, and limiting times	<i>700</i>		

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→ for total daily exposure of personnel with and without standard Air Force ear protectors. Refer to Volume 1 of this handbook, "USAF Bioenvironmental Noise Data Handbook, Vol. 1: Organization, Content and Application", AMRL-TR-75-50(1) 1975, for discussion of the objective and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc.

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PREFACE

This report was prepared by the Biodynamic Environment Branch, Aerospace Medical Research Laboratory, under Project/Task 723104, Measurement and Prediction of Noise Environments of Air Force Operations.

The author acknowledges the efforts of Mr. Robert T. England and Mr. Robert G. Powell who conducted the field measurements, and Mr. John N. Cole who established the data analysis requirements and assisted in the preparation of this report. Mr. Henry Mohlman and Mr. David Eilerman of the University of Dayton assisted in the mechanics of data processing, and Mrs. Norma Peachey typed and prepared the graphics.

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NEAR-FIELD NOISE

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INTRODUCTION

The D-4 Hydraulic Test Stand is an electric motor-driven unit designed to test aircraft hydraulic systems.

This volume provides measured data defining the bioacoustic environments produced by this unit. Such data are essential to evaluate ear protection requirements, limiting personnel exposure times, voice communication capabilities, and annoyance problems associated with operations of the D-4 test stand.

This volume is one of a series published by the Aerospace Medical Research Laboratory (AMRL) under the same report number (AMRL-TR-75-50) as a multi-volume handbook that quantifies the noise environments produced at flight/ground crew locations and in surrounding communities by operations of Air Force aircraft and ground support equipment. The far-field, community-type, noise data in the handbook describe the noise produced during *ground operations* of aircraft, ground support equipment, and other ground-based equipment or facilities.

Volume 1 of this handbook discusses the objectives and design of the handbook, the types of data presented, measurement procedures, instrumentation, data processing, definitions of quantities, symbols, equations, applications, limitations, etc. Volume 2 provides a method and data for adjusting the handbook's far-field noise data, which are for standard meteorological conditions (15C temperature, 0% rel humidity, 0.760 meters Hg barometric pressure) to derive comparable data for other meteorological conditions. Refer to Volumes 1 and 2 (references 1 and 2) for such information because it is not repeated in other handbook volumes.

A cumulative index lists those aerospace systems contained in the handbook, and identifies the specific volumes containing each type of environmental noise data available (i.e., inflight/flight crew and passenger noise, near-field/ground crew noise, far-field/community noise). Volume numbers are assigned sequentially as individual volumes are published. This index is periodically updated as individual volumes are published, and is available upon request from AMRL/BBE, Wright-Patterson AFB, OH 45433. Organizations on the distribution list for the handbook will automatically receive a copy of the updated index as it is generated.

Direct any questions concerning the technical data in this report and other handbook volumes to: AMRL/BBE, Wright-Patterson AFB, OH 45433; Autovon 78-53675 or 78-53664; Commercial (513) 55-3675 or (513) 255-3664.

. Cole, John N., *USAF Bioenvironmental Noise Data Handbook, Volume 1: Organization, Content and Application*, AMRL-TR-75-50 (1), Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, 1975.

. Cole, John N., *USAF Bioenvironmental Noise Data Handbook, Volume 2: Procedure to Evaluate Effects of Non-standard Meteorological Conditions on Far-Field Noise*, AMRL-TR-75-50 (2), AMRL, WPAFB, OH, 1975.

NEAR-FIELD NOISE

MEASUREMENTS

A standard D-4 Test Stand was operated inside, and approximately in the center of a large aircraft hanger (167.6 m long \times 36.6 m wide \times 18.3 m high) on a concrete floor at a normal rated/loaded condition. The hanger walls and ceiling were not acoustically treated. No aircraft were in the vicinity of the unit while being measured. No far-field acoustic data were acquired because of the relatively close proximity of the hanger walls.

Figure 1 identifies 36 noise measurement locations at a height of 1.5 meters above the concrete apron (nominal ear level of ground crew). The 0 degree reference direction passes through the tow bar. These locations are in the acoustic near-field of the source where the sound wave fronts generally do not spherically diverge and the source appears to be spatially distributed (i.e., not a point source). Consequently, these near-field data cannot be extrapolated to longer distances but do properly define the levels at locations close to the unit.

Near-field measurements were also made at ear level at the operator control panel. Table 1 lists the numeric/alphabetic designators used on the data pages in this report to identify the operator measurement location and test conditions. The designator 1/A means operator location 1 and test condition A. Such a descriptor is essential in many handbook volumes that involve multiple combinations of locations/conditions. It is used in this report to maintain format consistency.

RESULTS

The measured data presented in Table 2 define the sound pressure levels (SPL) produced by the D-4 unit at the 37 specified, near-field locations. This table includes the overall, 1/3 octave band, and octave band levels. From these data one can calculate the variety of measures in Table 3 which are widely used to assess the effects of noise on personnel and their performance.

For data at other intermediate near-field locations (i.e., for radial distances less than 4 meters) you can interpolate between the 36 measured data points.

TABLE I

MEASUREMENT LOCATION AND TEST CONDITIONS FOR OPERATOR NOISE MEASUREMENTS

**D-4 Test Stand, Aircraft Hydraulic System
Wright Patterson AFB, 2 Nov 1972
FSN 4520-817-1793**

Measurement Location

1 Operator Control Panel

Operation

A System Pressurized

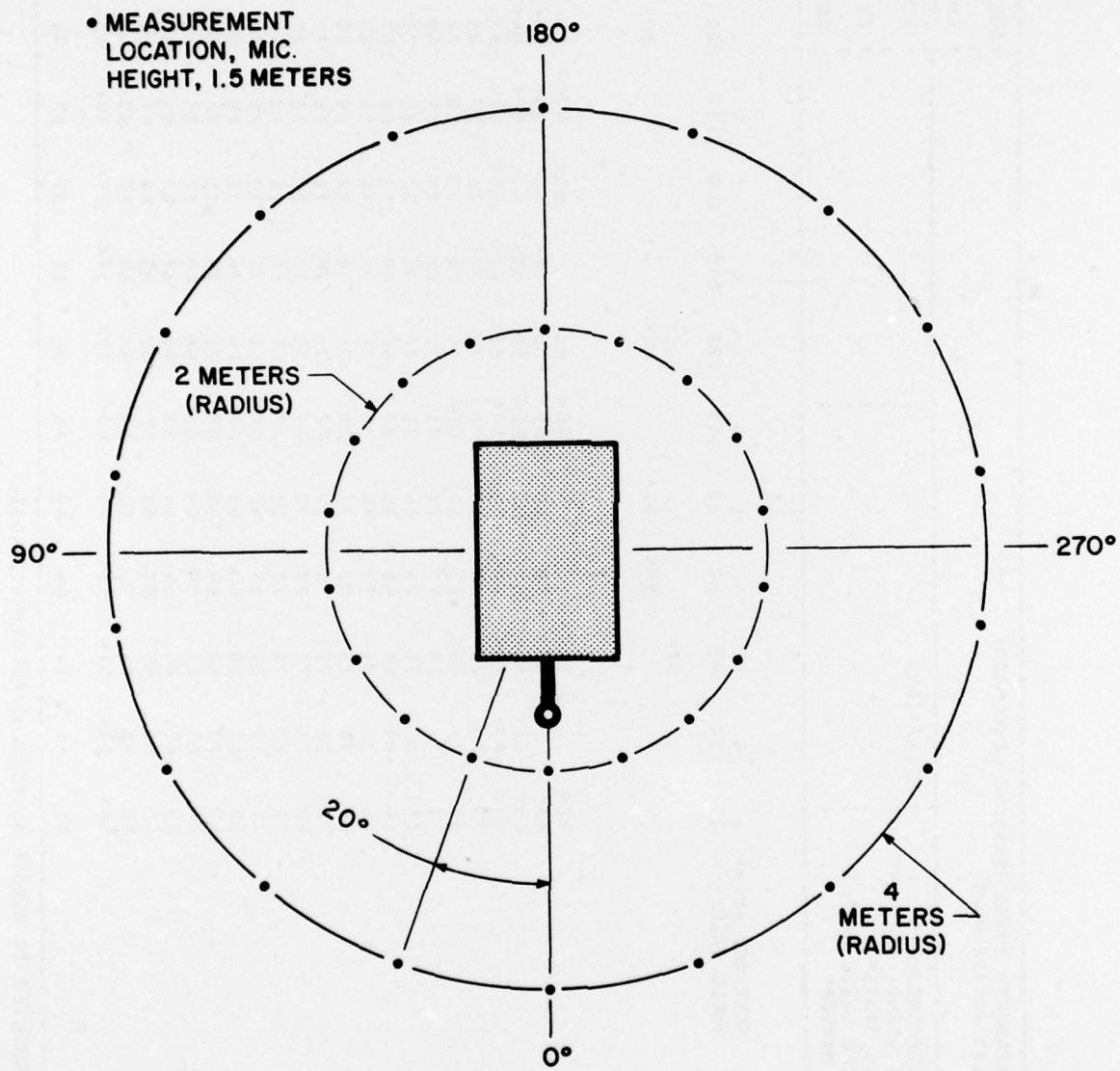


Figure 1. Measurement Locations

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)
2 1/3 OCTAVE BAND

NOISE SOURCE/SUBJECT		OPERATIONS				IDENTIFICATION			
D-4 TEST STAND, AIRCRAFT HYDRAULIC SYSTEM						OMEGA 3.2			
NEAR FIELD NOISE LEVELS						TEST 71-020-400			
(INSIDE HANGER)						RUN 02			
						20 AUG 74			
						PAGE F2			
FREQ (HZ)	DISTANCE (M) ->	4	4	4	4	2	2	2	2
	ANGLE (DEG) -->	260	280	300	320	340	20	40	60
25						60<			
31.5									59<
40									59<
50									
63									
80	60<	59<	59<	61<	58<	58<	58<	58<	58<
100	60<	59<	66<	68<	73	74	70	68<	70
125	61<	59<	60<	61<	64<	63<	61<	60<	62<
160	61<	59<	61<	62<	69	68	64<	62<	63<
200	78	72	77	68	81	87	83	81	70
250	70	68	69	64<	71	76	73	71	67<
315	78	73	74	73	71	78	74	73	70
400	81	77	76	80	75	82	82	79	76
500	65	67	65	69	64	70	68	71	65
630	74	74	78	70	72	78	76	70	73
800	75	83	77	78	79	78	77	80	74
1000	78	77	78	81	76	78	74	72	75
1250	73	74	72	73	72	75	74	72	73
1600	71	76	73	70	69	74	75	70	71
2000	71	72	71	72	72	75	76	73	74
2500	73	72	75	74	71	73	74	71	70
3150	75	71	75	74	73	72	76	69	68
4000	72	72	71	73	72	72	72	71	67
5000	68	69	68	68	68	68	69	65	69
6300	64	64	63	64	63	64	65	63	61
8000	61	62	61	60	58<	58<	59	57	57
10000	59	59	59	58<	57<	58<	56<	54<	53<
OVERALL	87	87	86	87	86	90	88	86	85
						90	88	86	85
						86	85	87	86

< LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE 1 MEASURED SOUND PRESSURE LEVEL (DB)
2 1/3 OCTAVE BAND

NOISE SOURCE/SUBJECT		OPERATION		TEST 71-020-400		TEST 71-020-400		TEST CONDITION			
FREQ (HZ)	ANGLE (DEG) ->	160	180	200	220	240	260	280	300	320	340
25	31.5	59<	62<	62<	62<	62<	60<	63<	59<	60<	66<
50	40	60<	62<	61<	59<	61<	62<	63<	64<	64<	62<
63	50	65<	72	67<	66<	67<	59<	67<	70	69	63<
80	63	65<	69	65<	64<	64<	62<	62<	64<	66<	64<
100	72	67	70	69	67	67	68	68	68	69	72
125	67	81	71	81	84	86	89	89	88	85	91
160	81	74	70	74	76	78	79	79	78	74	80
200	74	76	74	77	73	74	75	76	75	75	80
250	76	84	81	80	83	84	83	83	82	84	80
315	84	73	77	73	74	75	76	76	75	75	80
400	73	72	78	77	72	76	73	72	73	73	85
500	78	81	82	76	86	86	82	81	80	75	84
630	78	77	79	85	83	84	83	77	84	82	80
800	79	87	83	86	83	83	85	81	79	79	85
1000	79	81	90	89	81	87	84	85	85	85	85
1250	79	82	76	79	77	77	79	78	77	77	81
1600	81	75	76	76	77	78	79	80	74	77	81
2000	78	76	75	77	76	77	76	76	77	76	79
2500	77	74	79	78	79	79	75	77	75	73	79
3150	79	77	77	80	80	81	79	81	77	75	81
4000	77	78	81	81	81	81	76	79	76	74	79
5000	73	72	76	74	74	73	73	72	71	68	74
6300	68	66	68	70	70	70	68	68	66	70	70
8000	63	64	65	66	66	65	65	65	64	62	67
10000	61	61	63	64	63	63	63	63	62	60	63
OVERALL	90	91	94	93	93	94	93	93	93	90	95

< LEVEL CORRECTED TO REMOVE BACKGROUND/ELECTRONIC NOISE.

TABLE 2		MEASURED SOUND PRESSURE LEVEL (DB)										IDENTIFICATION:			
		OPERATION:													
NOISE SOURCE/SUBJECT:		D-4 TEST STAND, AIRCRAFT HYDRAULIC SYSTEM NEAR FIELD NOISE LEVELS (INSIDE HANGER)										OMEGA 3.2 TEST 71-020-400 RUN 01 20 AUG 74 PAGE J1			
FREQ (HZ)	DISTANCE (M) -->	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	ANGLE (DEG) -->	0	20	40	60	80	100	120	140	160	180	200	220	240	
31.5															
63		69	65	69	71	68	70	67	70	68	68	70	69	69	
125		76	77	80	76	75	80	83	78	80	85	80	82	82	
250		79	82	80	78	82	82	81	81	81	83	81	84	84	
500		80	79	78	76	75	74	80	83	78	82	83	82	82	
1000		74	75	74	73	73	72	77	76	78	77	79	77	77	
2000		74	73	73	73	72	74	73	75	76	75	78	76	76	
4000		64	63	61	60	59	59	64	66	66	67	66	67	68	
8000	OVERALL	85	85	84	84	83	84	85	87	87	89	89	88	88	

TABLE: MEASURED SOUND PRESSURE LEVEL (DB)
2 OCTAVE BAND

NOISE SOURCE/SUBJECT		OPERATION		IDENTIFICATION	
D-4 TEST STAND, AIRCRAFT				OMEGA 3.2	
HYDRAULIC SYSTEM				TEST 71-020-400	
NEAR FIELD NOISE LEVELS				RUN 02	
(INSIDE HANGER)				20 AUG 74	
					PAGE J2
FREQ (HZ)	DISTANCE (M) ->	4	4	4	2
	ANGLE (DEG) ->	260	280	300	320
		340	340	0	20
				20	40
				60	80
				100	120
				140	2
31.5					
63					
125					
250					
500					
1000					
2000					
4000					
8000					
OVERALL		87	87	86	86
				86	85
				87	87
				88	88

TABLE I MEASURED SOUND PRESSURE LEVEL (DB)
OCTAVE BAND 2

TABLE 3 MEASURES OF HUMAN NOISE EXPOSURE

		HAZARD/PROTECTION						IDENTIFICATION					
		C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DBC) AT EAR						TEST 71-020-400					
		A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DBA) AT EAR						RUN 01					
		MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)						PAGE H1					
		NO PROTECTION						PAGE H1					
NOISE SOURCE/SUBJECT:	OPERATION:	0	20	40	60	80	100	4	4	4	4	4	4
D-4 TEST STAND, AIRCRAFT HYDRAULIC SYSTEM								120	140	160	180	200	220
NEAR FIELD NOISE LEVELS (INSIDE HANGER)													240
		DISTANCE (M) -->						DISTANCE (M) -->					
		ANGLE (DEG) -->						ANGLE (DEG) -->					
OASLC	84	85	84	84	83	84	84	85	87	86	86	86	88
OASLA	83	83	82	81	81	82	82	82	84	85	85	86	86
T	571	571	679	807	807	679	679	480	404	404	339	285	339
MINIMUM QPL EAR MUFFS	59	61	60	60	58	60	61	63	61	62	64	63	63
OASLA*	960	960	960	960	960	960	960	960	960	960	960	960	960
T	960	960	960	960	960	960	960	960	960	960	960	960	960
AMERICAN OPTICAL 1700 EAR MUFFS	54	55	54	55	52	55	56	56	58	55	57	60	58
OASLA*	960	960	960	960	960	960	960	960	960	960	960	960	960
V-51R EAR PLUGS	59	59	58	56	56	58	58	60	61	60	61	63	62
OASLA*	960	960	960	960	960	960	960	960	960	960	960	960	960
T	960	960	960	960	960	960	960	960	960	960	960	960	960
AMERICAN OPTICAL 1700 EAR MUFFS PLUS V-51R EAR PLUGS	45	44	43	42	42	43	42	45	47	45	47	48	48
OASLA*	960	960	960	960	960	960	960	960	960	960	960	960	960
T	960	960	960	960	960	960	960	960	960	960	960	960	960
H-133 GROUND COMMUNICATION UNIT	55	55	55	54	53	53	54	57	57	57	58	60	58
OASLA*	960	960	960	960	960	960	960	960	960	960	960	960	960
T	960	960	960	960	960	960	960	960	960	960	960	960	960
COMMUNICATION PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)	78	78	76	76	77	76	79	80	79	80	82	81	
PSIL													
ANNOYANCE PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB)	98	96	96	95	96	97	99	98	100	100	101	101	
TONE CORRECTION (C IN DB)	2	3	2	2	2	2	3	2	2	2	3	2	
PNLT	97												
C	2												

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

TABLE I MEASURES OF HUMAN NOISE EXPOSURE

3

IDENTIFICATION									
NOISE SOURCE/SUBJECT:	OPERATION								
D-4 TEST STAND, AIRCRAFT									
HYDRAULIC SYSTEM									
NEAR FIELD NOISE LEVELS									
(INSIDE HANGER)									
DISTANCE (M) -->	4	4	4	4	4	4	2	2	2
ANGLE (DEG) -->	260	260	300	320	340	0	20	40	60
HAZARD/PROTECTION									
C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DBC) AT EAR									
A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DBA) AT EAR									
MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)									
NO PROTECTION									
OASLC	87	87	86	86	90	88	86	85	87
OASLA	85	86	85	86	84	87	86	82	84
T	404	339	404	339	480	285	339	404	480
MINIMUM QPL EAR MUFFS									
OASLA*	62	60	61	61	61	67	63	63	63
T	960	960	960	960	960	960	960	960	960
AMERICAN OPTICAL 1700 EAR MUFFS									
OASLA*	57	54	55	55	56	62	59	58	57
T	960	960	960	960	960	960	960	960	960
V-51R EAR PLUGS									
OASLA*	60	62	60	61	59	63	60	62	58
T	960	960	960	960	960	960	960	960	960
AMERICAN OPTICAL 1700 EAR MUFFS PLUS									
OASLA*	46	48	46	47	45	48	47	47	44
T	960	960	960	960	960	960	960	960	960
H-133 GROUND COMMUNICATION UNIT									
OASLA*	56	58	58	59	57	59	57	55	55
T	960	960	960	960	960	960	960	960	960
COMMUNICATION PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)									
PSIL	79	81	80	78	81	80	81	77	77
ANNOYANCE									
PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDB)									
TONE CORRECTION (C IN DB)									
PNLT	100	99	100	99	98	101	101	100	98
C	2	2	3	2	2	2	2	3	2

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.

TABLE I MEASURES OF HUMAN NOISE EXPOSURE
3

NOISE SOURCE/SUBJECT		OPERATION		IDENTIFICATION													
D-4 TEST STAND, AIRCRAFT)		1 OMEGA 3-2													
HYDRAULIC SYSTEM)		TEST 71-020-400													
NEAR FIELD NOISE LEVELS)		RUN 03													
(INSIDE HANGER)))													
)		20 AUG 74)													
)		PAGE H3)													
DISTANCE (IN) →	ANGLE (DEG) →	160	180	200	220	240	260	280	300	320	340	2	2	OPERATOR LOCATION			
														TEST CONDITION			
														1/A			
HAZARD/PROTECTION						C-WEIGHTED OVERALL SOUND LEVEL (OASLC IN DB) AT EAR						A-WEIGHTED OVERALL SOUND LEVEL (OASLA IN DBA) AT EAR					
NO PROTECTION						MAXIMUM PERMISSIBLE TIME (T IN MINUTES) FOR ONE EXPOSURE PER DAY (AFR 161-35, JULY 73)						NO PROTECTION					
OASLC						90	91	93	94	93	93	90	90	93	90	95	
OASLA						89	91	92	91	91	90	89	88	89	88	92	
T						202	143	120	143	143	170	170	202	240	240	120	
MINIMUM QPL EAR MUFFS						65	64	69	68	69	69	69	69	65	65	70	
OASLA*						960	960	960	960	960	960	960	960	960	960	960	
T						60	58	63	63	62	65	64	64	64	64	66	
AMERICAN OPTICAL 1700 EAR MUFFS						960	960	960	960	960	960	960	960	960	960	960	
OASLA*						63	66	68	67	66	66	66	66	65	63	67	
T						960	960	960	960	960	960	960	960	960	960	960	
V-51R EAR PLUGS						53	53	53	52	52	52	52	50	50	50	53	
OASLA*						960	960	960	960	960	960	960	960	960	960	960	
AMERICAN OPTICAL 1700 EAR MUFFS PLUS						49	53	53	52	52	52	52	50	50	50	53	
OASLA*						960	960	960	960	960	960	960	960	960	960	960	
H-133 GROUND COMMUNICATION UNIT						62	64	63	64	64	63	63	62	61	61	65	
T						960	960	960	960	960	960	960	960	960	960	960	
COMMUNICATION						PREFERRED SPEECH INTERFERENCE LEVEL (PSIL IN DB)						ANNOYANCE					
PSIL						84	84	86	86	86	86	85	84	82	82	86	
ANNOYANCE						PERCEIVED NOISE LEVEL, TONE CORRECTED (PNLT IN PNDdB)						TONE CORRECTION (C IN DB)					
PNLT						103	104	106	106	106	105	106	104	102	107	107	
C						2	2	2	2	2	2	2	2	2	2	2	

* BASED ON CALCULATED SPL SPECTRUM UNDER PROTECTIVE DEVICE.